

## APPENDIX G – TRANSPORTATION

### G.1 INTRODUCTION

This appendix contains material supporting the transportation impacts analysis. It details Sandia National Laboratories/New Mexico (SNL/NM)-related transportation activities pertaining to waste and other material. The information is taken from various documents, databases, and reports. Referenced documents used in the analysis include facility source documents (SNL/NM 1998a); the *SNL/NM Environmental Information Document* (SNL/NM 1997h); the *Environmental Assessment for SNL/NM Offsite Transportation of Low-level Radioactive Waste*, DOE/EA-1180 (DOE 1996h); and the *Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement*, DOE/EIS-0249F (DOE 1996b). For additional information on waste generation, see Appendix H and Sections 5.3.10, 5.4.10, 5.5.10.

### G.2 SCOPE OF THE ANALYSIS

The transportation-related impacts evaluation involved the calculation of

- incident-free radiological doses to the crew and the public,
- accident consequences based on accident events and expected doses for a given accident (Category VIII),
- nonradiological impacts due to traffic fatalities, and
- latent cancer fatalities (LCFs) due to potential vehicle emissions of air pollutants.

These calculations were for combined lifetime fatalities from the transportation shipments of each material type. Overall impacts from all potential transportation activities for each of the alternatives considered in the SNL/NM Site-Wide Environmental Impact Statement (SWEIS) were also determined. The analysis focused on regular shipment origins and destinations and the bounding analyses for these locations. Due to the nature of SNL/NM operations, irregular (nonroutine) or one-time shipments of hazardous materials from around the world are possible. However, the nonroutine shipments pertaining to transuranic (TRU) waste and special projects, such as legacy waste and Environmental Restoration (ER) Project wastes, were

analyzed. The routine transportation operations analysis was conservative and bounding.

### G.3 MATERIAL SHIPMENTS AND RECEIPTS

The various material types considered to have the potential for transportation impacts resulting from SNL/NM operations include radioactive, chemical, explosive, and waste. Waste includes low-level waste (LLW); hazardous waste; low-level mixed waste (LLMW); solid waste; and other waste, including TRU, asbestos, biohazardous (medical), and polychlorinated biphenyls (PCBs).

The information required to determine the transportation impacts includes the number of shipments of each material type, potential origins of shipments, and potential destinations of shipments. This information was generated from available baseline data, projected material inventories, projected material usage, and projected waste generation presented in the facility source documents (SNL/NM 1998a) and associated inventory databases (such as the *Chemical Information System* [CIS]).

#### G.3.1 Radioactive Material

Shipping and receiving records from 1997 were used to calculate related transportation impacts for radioactive material. This information included the number of shipments and receipts, origins, and destinations. SNL/NM ships and receives radioactive material from various locations in the U.S.

For each alternative, the number of potential radioactive material shipments was calculated using the normalized activity multipliers presented in Appendix A. The results are shown in [Table G.3–1](#).

The longest and most representative route was selected for a bounding analysis. This was accomplished by reviewing baseline shipments and receipts information. The route from SNL/NM to Mountain Top, Pennsylvania, was selected to model from the many routes used in 1997 for radioactive material shipments and receipts ([Table G.3–2](#)). The modeled route was screened and represented the route with the largest number of shipments, longest distance, and highest population distribution (Section G.6).

**Table G.3–1. Estimated Total Annual Shipments and Receipts of Radioactive Material by Alternative**

| ACTIVITY                  | BASE YEAR<br>1997 | NO ACTION ALTERNATIVE |      | EXPANDED<br>OPERATIONS<br>ALTERNATIVE | REDUCED<br>OPERATIONS<br>ALTERNATIVE |
|---------------------------|-------------------|-----------------------|------|---------------------------------------|--------------------------------------|
|                           |                   | 2003                  | 2008 |                                       |                                      |
| <i>Tests/Shots</i>        | 36                | 66.3                  | 70.4 | 210.3                                 | 16.5                                 |
| <i>Shipments/Receipts</i> | 305               | 562                   | 597  | 1,782                                 | 140                                  |

Source: SNL/NM 1998a

Table G.3–1 shows that in 1997, 36 tests/shots resulted in 305 shipments or receipts. Projected tests/shots presented in the SNL/NM facility source documents would require shipments or receipts ranging from 140 under the Reduced Operations Alternative to 1,782 under the Expanded Operations Alternative.

### G.3.2 Chemicals

A review of the CIS database and inventories and usage information on chemicals determined that approximately 80 percent of the chemicals supplied to SNL/NM were from 11 vendors making approximately 1 delivery per day, excluding bulk chemicals such as liquid nitrogen. These chemicals included a variety of hazardous and nonhazardous materials, including solvents, corrosives, and flammables.

For the SWEIS analysis, the bounding calculation assumed the supplies would be located within 40 km of SNL/NM and delivered from a centralized facility. Using the following equation, the calculated number of annual shipments would be 2,750.

$$11 \text{ vendors/day} \times 1 \text{ shipment/vendor} \times 5 \text{ days/week} \times 50 \text{ weeks/year} = 2,750 \text{ shipments/year}$$

(Eq. G.3–1)

The number of shipments would not vary by alternative, but the amount of material shipped could vary to accommodate the material requirements under each alternative. Table G.3–3 shows 2,750 shipments per year for each alternative.

### G.3.3 Explosives

Most of the transportation involving explosives is expected to be by onsite transfer. These transfers are typically small in quantity, of short duration, and do not

contribute a notable portion to the transportation impacts. Offsite transportation impacts are considered risk-dominant and bound onsite transfers of explosive materials.

For the SWEIS analysis, the longest route for explosives was selected for a bounding analysis. The longest route is from Albuquerque, New Mexico, to Silverdale, Washington, a distance of approximately 2,406 km. The projected consumption rates of explosive materials were similarly based on the facility source document projections for the baseline and activity multipliers presented in Appendix A. In 1997, 303 offsite explosive material shipments and receipts were recorded (Table G.3–3).

For each alternative, the numbers of potential explosive material shipments were calculated using the projected number of shipments compared to the baseline ratio of explosive shipments to the number of activities (see Appendix A). Table G.3–3 presents the potential total number of explosives shipments/receipts by alternative.

### G.3.4 Wastes

Various types of waste are generated at SNL/NM, including LLW, LLMW, and hazardous waste. For a detailed discussion of these waste types and other waste generation impacts by alternative, see Sections 5.3.10, 5.4.10, 5.5.10, and Appendix H.

Shipments of LLW, LLMW, hazardous waste, TRU waste, and solid waste were considered in the transportation impacts analysis. For completeness, recyclable hazardous waste, decontamination and decommissioning (D&D) waste, other solid waste, legacy waste, and ER Project waste were also included in the analysis. These waste categories (see Table G.3–3) are discussed in the following sections, and the number of shipments for each waste type for the base year and for each of the alternatives was evaluated for transportation impacts.

**Table G.3–2. Truck Traffic Bounding Case Distances**

| <b>MATERIAL TYPES<sup>a</sup></b>                | <b>ORIGIN-DESTINATION</b>                    | <b>DISTANCE<br/>(km)</b> |
|--|--|--------------------------|
| <b>Radioactive</b>                               | SNL/NM Bounding distance to Mountain Top, PA | 3,022                    |
| <b>Chemical</b>                                  | Albuquerque to SNL/NM                        | 40                       |
| <b>Explosive</b>                                 | SNL/NM to Silverdale, WA                     | 2,406                    |
| <b>LLW</b>                                       | SNL/NM to Clive, UT                          | 1,722                    |
| <b>LLMW (Receipt)</b>                            | SNL/CA to SNL/NM                             | 1,780                    |
| <b>LLMW (Shipment)</b>                           | SNL/NM to Savannah River Site, SC            | 2,548                    |
| <b>Hazardous Waste (Shipment)</b>                | SNL/NM to Clive, UT                          | 1,722                    |
| <b>Hazardous Waste (Receipt)</b>                 | Local  | 13                       |
| <b>Hazardous Waste (California) (Recyclable)</b> | SNL/NM to Anaheim, CA                        | 1,306                    |
| <b>Hazardous Waste (Local) (Recyclable)</b>      | SNL/NM to Albuquerque, NM                    | 32                       |
| <b>Hazardous Solid Waste (D&amp;D)</b>           | Local  | 32                       |
| <b>Nonhazardous Solid Waste (Recyclable)</b>     | Local  | 32                       |
| <b>Nonhazardous Landscaping (Recyclable)</b>     | SNL/NM to Rio Rancho, NM                     | 50                       |
| <b>Solid Waste (Municipal and C&amp;D)</b>       | SNL/NM to Rio Rancho Sanitary Landfill, NM   | 50                       |
| <b>TRU/MTRU Waste</b>                            | SNL/NM to Los Alamos National Laboratory, NM | 167                      |
| <b>Hazardous Waste TSCA-PCBs (D&amp;D)</b>       | SNL/NM to Clive, UT                          | 1,722                    |
| <b>Hazardous Waste TSCA-Asbestos (D&amp;D)</b>   | SNL/NM to Mountainair, NM                    | 190                      |
| <b>LLW (D&amp;D)</b>                             | SNL/NM to Clive, UT                          | 1,722                    |
| <b>Biohazardous Waste (Medical)</b>              | SNL/NM to Aragonite, UT                      | 1,114                    |
| <b>Legacy LLW (Storage)</b>                      | SNL/NM to Clive, UT                          | 1,722                    |
| <b>Legacy LLMW (Storage)</b>                     | SNL/NM to Savannah River Site, SC            | 2,548                    |
| <b>Legacy TRU/MTRU (Storage)</b>                 | SNL/NM to Los Alamos National Laboratory, NM | 167                      |
| <b>LLW (ER Project)</b>                          | SNL/NM to Clive, UT                          | 1,722                    |
| <b>LLMW (ER Project)</b>                         | SNL/NM to Savannah River Site, SC            | 2,548                    |
| <b>RCRA Hazardous Waste (ER Project)</b>         | SNL/NM to Clive, UT                          | 1,722                    |
| <b>Nonhazardous Solid Waste (ER Project)</b>     | SNL/NM to Rio Rancho, NM                     | 50                       |

Sources: DOE 1996h, SNL 1992a, SNL/NM 1998a

C&amp;D: construction and demolition

D&amp;D: decontamination and decommissioning

ER: Environmental Restoration

km: kilometer

LLW: low-level waste

LLMW: low-level mixed waste

MTRU: mixed transuranic

PCB: polychlorinated biphenyl

RCRA: Resource Conservation and Recovery Act

SNL/NM: Sandia National Laboratories/New Mexico

TRU: transuranic

TSCA: Toxic Substances Control Act

<sup>a</sup>Material types are used in or generated from normal operations unless otherwise noted.

**Table G.3–3. Summary of Annual Shipments or Receipts for Transportation Impacts**

| MATERIAL TYPE <sup>a</sup>  | BASE YEAR<br>(TYPICALLY<br>1996) | NO ACTION<br>ALTERNATIVE |       | EXPANDED<br>OPERATIONS<br>ALTERNATIVE | REDUCED<br>OPERATIONS<br>ALTERNATIVE |
|---|----------------------------------|--------------------------|-------|---------------------------------------|--------------------------------------|
|   |                                  | 2003                     | 2008  |                                       |                                      |
| <b>Radioactive</b>  | 305                              | 562                      | 597   | 1,782                                 | 140                                  |
| <i>Radioactive MIPP (Receipt)</i>                                     | 0                                | 16                       | 16    | 55                                    | 2                                    |
| <i>Radioactive MIPP (Shipment)</i>                                    | 0                                | 1,140                    | 1,140 | 1,140                                 | 1,140                                |
| <b>Chemical</b>   | 2,750                            | 2,750                    | 2,750 | 2,750                                 | 2,750                                |
| <b>Explosive</b>  | 303                              | 557                      | 593   | 1,771                                 | 138                                  |
| <b>LLW</b>  | 4                                | 13                       | 13    | 21                                    | 8                                    |
| <i>LLMW (Receipt)</i>   | 0                                | 1                        | 1     | 1                                     | 1                                    |
| <i>LLMW (Shipment)</i>  | 1                                | 3                        | 3     | 3                                     | 3                                    |
| <i>RCRA Hazardous Waste (Shipment)</i>                                | 64                               | 80                       | 84    | 112                                   | 58                                   |
| <i>RCRA Hazardous Waste (Receipt)</i>                                 | 12                               | 25                       | 25    | 25                                    | 25                                   |
| <i>Hazardous Waste (California) (Recyclable)</i>                      | 2                                | 3                        | 3     | 4                                     | 2                                    |
| <i>Hazardous Waste (Local) (Recyclable)</i>                           | 6                                | 8                        | 8     | 11                                    | 6                                    |
| <i>Hazardous Waste (D&amp;D)</i>                                      | 22                               | 22                       | 22    | 22                                    | 22                                   |
| <i>Nonhazardous Solid Waste (Recyclable)</i>                          | 78                               | 78                       | 78    | 78                                    | 78                                   |
| <i>Nonhazardous Landscaping (Recyclable)<sup>b</sup></i>              | NA                               | 142                      | 142   | 142                                   | 142                                  |
| <i>Solid Waste</i>  | 51                               | 51                       | 51    | 51                                    | 51                                   |
| <i>Construction And Demolition<sup>b</sup><br/>Solid Waste (KAFB)</i> | NA                               | 599                      | 599   | 599                                   | 599                                  |
| <i>TRU/MTRU Waste</i>   | 0                                | 1                        | 3     | 4                                     | 2                                    |
| <i>Hazardous Waste TSCA-PCBs (D&amp;D)</i>                            | 1                                | 1                        | 1     | 1                                     | 1                                    |
| <i>Hazardous Waste TSCA-Asbestos (D&amp;D)</i>                        | 14                               | 14                       | 14    | 14                                    | 14                                   |
| <i>LLW (D&amp;D)</i>  | 4                                | 4                        | 4     | 4                                     | 4                                    |
| <i>Biohazardous Waste (Medical)</i>                                   | 1                                | 1                        | 1     | 1                                     | 1                                    |

Sources: DOE 1996h, SNL 1992a, SNL/NM 1998a

D&amp;D: decontamination and decommissioning

ER: Environmental Restoration

KAFB: Kirtland Air Force Base

LLW: low-level waste

LLMW: low-level mixed waste

MIPP: Medical Isotopes Production Project

MTRU: mixed transuranic

NA: not applicable

PCB: polychlorinated biphenyl

RCRA: Resource Conservation and Recovery Act

TRU: transuranic

TSCA: Toxic Substances Control Act

<sup>a</sup> Material type is used or generated during normal operations unless otherwise noted<sup>b</sup> Recycled and solid waste currently handled by the KAFB landfill could be shipped offsite in the future.

### G.3.4.1 Low-Level Waste

The analysis considered four potential LLW disposal sites: Hanford, Washington; Nevada Test Site (NTS), Nevada; Savannah River Site (SRS), South Carolina; and Clive, Utah. It is expected that the disposal of LLW would continue at facilities such as the Envirocare facility located outside of Clive, Utah. There were four shipments in 1996, the base year for analysis. Following are the projected numbers of LLW shipments: No Action Alternative–13, Expanded Operations Alternative–21, and Reduced Operations Alternative–8 (Table G.3–3). Other routine shipments would be possible between SNL/NM and Hanford or SNL/NM and NTS. However, Table G.3–4 shows that the impacts in person-rem per shipment would be comparable among all four disposal sites.

### G.3.4.2 Low-Level Mixed Waste

In the future, LLMW would be shipped to facilities such as the Idaho National Engineering and Environmental Laboratory, Envirocare, Diversified Scientific Services, Inc., Waste Control Specialists, Inc., Oak Ridge, and SRS for treatment or disposal. For bounding purposes, SRS was chosen as the representative treatment disposal site at a distance of approximately 2,548 km. For the base year (1996), one offsite LLMW shipment and one onsite receipt from SNL/California (CA) was considered. The projected numbers of LLMW shipments would remain constant under all alternatives (see Table G.3–3).

### G.3.4.3 Hazardous Waste

In 1996, the total number of hazardous waste shipments was 91; the ER Project was responsible for 27 of those shipments. Only normal operations-related shipments

(64) were considered routine. Table G.3–3 presents the expected number of shipments by alternative. SNL/NM uses multiple hazardous waste disposal facilities located throughout the U.S. The longest route for hazardous waste was selected for the SWEIS bounding analysis: Albuquerque, New Mexico, to Clive, Utah, a distance of approximately 1,722 km (Table G.3–2). The projected numbers of hazardous waste shipments would be: No Action Alternative–84, Expanded Operations Alternative–112, and Reduced Operations Alternative–58.

### G.3.4.4 Solid Waste

Solid waste is generally picked up once a week. In 1997, 51 shipments were made from SNL/NM to the Rio Rancho Sanitary Landfill. The bounding calculation assumed that the disposal of solid waste would be located within 50 km for the SWEIS analysis. These shipments would not be expected to vary over the time frame of the SWEIS. Table G.3–3 shows the number of shipments would be constant at 51 for each of the alternatives. In addition, should the Kirtland Air Force Base (KAFB) landfill close, construction and demolition debris shipments (599 per year) would likely go to the Rio Rancho Sanitary Landfill or the Cerro Colorado Landfill. Landscaping waste, also handled at the KAFB landfill, would be required to be shipped offsite (142 per year).

### G.3.4.5 Recycled Hazardous Material

In 1997, two recycled hazardous material shipments were made to Anaheim, California. Six shipments were made to a local facility in Albuquerque, New Mexico (see Tables G.3–2 and G.3–3).

**Table G.3–4. Low-Level Waste Disposal Sites**

| DISPOSAL<br>ROUTE/SITE<br>FROM<br>SNL/NM | CLASSIFICATION DISTANCE<br>(km) |          |       | TOTAL<br>DISTANCE<br>(km) | INCIDENT-FREE IMPACT,<br>PERSON-REM PER UNIT SHIPMENT |                            |                           |                      |
|--|---------------------------------|----------|-------|---------------------------|---|----------------------------|---------------------------|----------------------|
|  | RURAL                           | SUBURBAN | URBAN |                           | DOSE TO<br>CREW                                       | PUBLIC<br>OFF-LINK<br>DOSE | PUBLIC<br>ON-LINK<br>DOSE | STOP                 |
| <i>Hanford, WA</i>                       | 2,324                           | 224      | 36    | 2,584                     | $7.8 \times 10^{-2}$                                  | $2.0 \times 10^{-3}$       | $1.4 \times 10^{-2}$      | 0.22                 |
| <i>NTS, NV</i>                           | 945                             | 68       | 25    | 1,038                     | $3.2 \times 10^{-2}$                                  | $2.0 \times 10^{-3}$       | $1.2 \times 10^{-2}$      | $8.6 \times 10^{-2}$ |
| <i>SRS, SC</i>                           | 2,051                           | 455      | 41    | 2,548                     | $8.0 \times 10^{-2}$                                  | $3.0 \times 10^{-3}$       | $1.5 \times 10^{-2}$      | 0.22                 |
| <i>Clive, UT</i>                         | 1,533                           | 156      | 33    | 1,722                     | $5.2 \times 10^{-2}$                                  | $1.4 \times 10^{-3}$       | $1.0 \times 10^{-2}$      | 0.14                 |

Source: DOE 1996h

km: kilometer

NTS: Nevada Test Site

rem: Roentgen equivalent, man

SNL/NM: Sandia National Laboratories/New Mexico

SRS: Savannah River Site

Notes: 1) On-link means occupants of vehicles that share the transportation corridor with the radioactive shipment.

2) Off-link means people by the side of the transportation corridor.

3) Stop means people in the vicinity of the shipment when it stopped.

### G.3.4.6 Transuranic and Mixed Transuranic Wastes

During normal operations, only minimal quantities of TRU and MTRU waste are generated at SNL/NM. As TRU and MTRU wastes are generated, they are collected and stored until sufficient quantities are accumulated for shipment. The existing TRU/MTRU wastes stored onsite, as well as all future TRU/MTRU wastes, would be transferred to Los Alamos National Laboratory (LANL) for certification, as indicated in the *Waste Management Programmatic Impact Statement [PEIS] for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997i) Record of Decision (ROD) (DOE 19998n), prior to disposal at the Waste Isolation Pilot Project (WIPP).

### G.3.4.7 Special Projects Waste

The wastes in storage (legacy wastes) and the wastes generated during special projects, such as ER Project wastes, were considered in the analysis as total shipments over a 5-year period. These waste shipments are presented in Table G.3–5.

**Table G.3–5. Summary of Total Shipments for Transportation Impacts Under Special Projects Over 5 Years**

| MATERIAL TYPE                                    | TOTAL NUMBER OF SHIPMENTS (OVER 5 YEARS) |
|--|--|
| <i>Legacy LLW<sup>a</sup></i>                    | 56                                       |
| <i>Legacy LLMW<sup>a</sup></i>                   | 8  |
| <i>Legacy TRU/MTRU<sup>a</sup></i>               | 2  |
| <i>LLW<sup>a</sup> (ER)</i>                      | 136                                      |
| <i>LLMW<sup>a</sup> (ER)</i>                     | 5  |
| <i>TSCA Hazardous Waste<sup>b</sup> (ER)</i>     | 113                                      |
| <i>Nonhazardous Solid Waste<sup>b</sup> (ER)</i> | 9  |

Source: SNL/NM 1998a  
ER: Environmental Restoration  
LLW: low-level waste  
LLMW: low-level mixed waste  
MTRU: mixed transuranic

TSCA: Toxic Substances Control Act  
TRU: transuranic  
<sup>a</sup> Storage operation  
<sup>b</sup> ER Project operation

For the transportation impact evaluation, the representative distances traveled for the receipt and shipment of SNL/NM special projects material and waste are summarized in Table G.3–2.

## G.4 RADTRAN 4 METHODOLOGY

Radiological transportation risk was modeled using *RADTRAN 4*, a computer modeling program developed at SNL/NM (SNL 1992a). *RADTRAN 4* models incident-free transportation as a separate module from transportation accidents. When radioactive materials are transported, compliance with an external dose limited by regulation (10 Code of Federal Regulations [CFR] Part 71) is required. Only external gamma radiation was considered, because external neutrons are absorbed by air before reaching a receptor. The radioactive cargo was modeled as a point source. Dose to the receptor is usually inversely proportional to the square of the distance from the receptor. Dose is also inversely proportional to vehicle velocity and directly proportional to distance traveled and to the number of shipments.

The radiation source was the external dose rate (mrem/hr) measured at 1 m from the cargo surface. *RADTRAN 4* models the regulatory limit of external dose for each type of shipment. Because the regulatory limit is the modeled dose, the modeled incident-free dose is independent of the isotopic content or radioactivity of the material being shipped. Doses were calculated separately for the truck crew (crew dose), people by the side of the transportation corridor (off-link dose), occupants of vehicles that share the transportation corridor with the radioactive shipment (on-link dose), and people in the vicinity of the shipment when it stopped (stop dose).

Because of similarities in highway vehicle speeds, vehicle densities, and vehicle accident rates, transportation routes were categorized as rural, suburban, or urban according to approximate population density. The actual distances and population density values were used in the *RADTRAN 4* model, retaining the rural, urban, and suburban classifications.

### G.4.1 Accident Consequences

The specific radioactive material being shipped and the activity of the material become important in transportation accident modeling. *RADTRAN 4* models the risk from emissions of fractions of the radioactive cargo into the air. This risk combines the probability of a breach of containment with the fraction of each isotope that would be leaked, aerosolized, and inhaled under a particular accident scenario. A detailed description of the accident severity category approach is contained in the Nuclear Regulatory Commission (NRC) document, NUREG-0170 (NRC 1977b).



The crew dose and the combined population dose from off-link, on-link, and stop components are presented in the results. Any component dose could be calculated by the unit shipment dose (Table G.4–1) and the number of shipments of a given material.

product of the number of packages and transport index (of each package) to a value of about 16 for a 1-m-size package. This bounds impacts expected as a result of SNL/NM operations. The amount of radioactive material per shipment was assumed to be 100 kg of

**Table G.4–1. Radiological Doses to Crew and Public Per Unit Shipment**

| MATERIAL TYPE               | ROUTE DESTINATION   | CREW                 | INCIDENT-FREE PUBLIC |                      |                      | ACCIDENT IMPACTS PUBLIC | TOTAL                |                      |
|-----------------------------|---------------------|----------------------|----------------------|----------------------|----------------------|-------------------------|----------------------|----------------------|
|                             |                     |                      | OFF-LINK             | ON-LINK              | STOPS                |                         | CREW                 | PUBLIC               |
| <b>Radioactive Material</b> | Mountain Top, PA    | $3.2 \times 10^{-2}$ | $2.4 \times 10^{-3}$ | $2.5 \times 10^{-2}$ | $2.4 \times 10^{-1}$ | $4.3 \times 10^{-5}$    | $3.2 \times 10^{-2}$ | $2.7 \times 10^{-1}$ |
| <b>LLW</b>                  | Clive, UT           | $5.2 \times 10^{-2}$ | $1.4 \times 10^{-3}$ | $1.0 \times 10^{-2}$ | $1.4 \times 10^{-1}$ | $5.8 \times 10^{-4}$    | $5.2 \times 10^{-2}$ | $1.5 \times 10^{-1}$ |
| <b>LLMW</b>                 | SRS                 | $2.6 \times 10^{-2}$ | $2.1 \times 10^{-3}$ | $2.0 \times 10^{-2}$ | $2.4 \times 10^{-1}$ | $3.4 \times 10^{-5}$    | $2.6 \times 10^{-2}$ | $2.6 \times 10^{-1}$ |
| <b>LLMW</b>                 | SNL/NM <sup>a</sup> | $1.8 \times 10^{-2}$ | $1.8 \times 10^{-3}$ | $5.5 \times 10^{-3}$ | $8.8 \times 10^{-2}$ | $4.4 \times 10^{-6}$    | $1.8 \times 10^{-2}$ | $9.5 \times 10^{-2}$ |
| <b>TRU/MTRU</b>             | LANL                | $1.8 \times 10^{-3}$ | $1.7 \times 10^{-4}$ | $1.6 \times 10^{-3}$ | $8.3 \times 10^{-3}$ | $3.4 \times 10^{-6}$    | $1.8 \times 10^{-3}$ | $1.0 \times 10^{-2}$ |

Sources: DOE 1996h, SNL 1992a  
 LANL: Los Alamos National Laboratory  
 LLMW: low-level mixed waste  
 LLW: low-level waste  
 MTRU: mixed transuranic

SNL/NM: Sandia National Laboratories/New Mexico  
 SNL/CA: Sandia National Laboratories/California  
 SRS: Savannah River Site  
 TRU: transuranic  
<sup>a</sup>Shipment from SNL/CA to SNL/NM

The *RADTRAN 4* code was used to calculate the incident-free dose to the crew and public and the dose to public due to accidental release of radioactivity during transport (SNL 1992a). The transportation impacts due to the movement of various materials discussed earlier for SNL/NM operations were evaluated under each of the alternatives. These impacts include the calculations of incident-free radiation dose to the drivers, material handlers, and the public; the dose to the public due to accidental release of radioactivity in transit; and nonradiological fatalities due to truck emissions and traffic accidents. The radiological dose impacts for the radioactive materials transport were calculated using the *RADTRAN 4* computer model (SNL 1992a).

*RADTRAN 4* combines user-determined demographic, transportation, packaging, and material data with health physics data to calculate expected radiological consequences for incident-free transporting of radioactive materials and accident risks. The transportation index is a regulatory characteristic of a package and is equal to the radiation dose rate, in mrem/hr, at a distance of 1 m from the outside of the package. The transportation index used for the calculations of radioactive material transport is a maximum allowed by regulatory requirements, as indicated by regulatory checks incorporated in *RADTRAN 4*. These regulatory checks limit the

depleted uranium (DU) (0.2 percent uranium-235), with a breakdown spectrum as shown in Table G.4–2. This material is considered representative of SNL/NM operational radioactive material activities.

**Table G.4–2. Radionuclide Content of Depleted Uranium per Shipment**

| ISOTOPE            | CURIES PER SHIPMENT  |
|--------------------|----------------------|
| <b>Uranium-232</b> | $8.8 \times 10^{-2}$ |
| <b>Uranium-234</b> | $2.2 \times 10^{-2}$ |
| <b>Uranium-235</b> | $4.2 \times 10^{-4}$ |
| <b>Uranium-238</b> | $3.3 \times 10^{-2}$ |

Source: DOE 1996i

The transportation accident model in *RADTRAN 4* assigns accident probabilities to a set of accident categories. For this truck transport analysis, the most severe category (Category VIII) in *RADTRAN 4* was exercised, representing a large crush force, high impact velocities, long fire duration, and high puncture-impact speed. The accident consequences were calculated based on a Category VIII accident only. The associated inhalable fraction was 0.1 of the modeled material during total release.

### G.4.2 Incident-Free Risk

The radiological incident-free doses to the drivers (crew) and the public were calculated for a single shipment, assuming the longest distance (Albuquerque, New Mexico, to Mountain Top, Pennsylvania) to determine a bounding transportation impact. The *HIGHWAY* routing model, which is an integral part of the *RADTRAN 4* model, was applied to calculate the distance between origin and destination along rural, suburban, and urban travel distance fractions. The doses to the crew and public for each material type were calculated by the *RADTRAN 4* model for a single

shipment. The doses per unit shipment are presented in Table G.4–1. The radiological transportation doses to the crew and public per shipment, due to LLW transport to the Clive, Utah, facility, were calculated from reported values in the *Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories/New Mexico* (DOE 1996h). The calculated incident-free radiological doses due to annual shipments for each of the alternatives are presented in Table G.4–3. The calculated lifetime incident-free radiological doses due to special project shipments are presented in Table G.4–4.

**Table G.4–3. Annual Incident-Free Doses to Crew and Public**

| MATERIAL TYPE <sup>a</sup>                   | BASE<br>YEAR <sup>b</sup> | NO ACTION ALTERNATIVE |                      | EXPANDED<br>OPERATIONS<br>ALTERNATIVE | REDUCED<br>OPERATIONS<br>ALTERNATIVE |
|--|---------------------------|-----------------------|----------------------|---------------------------------------|--------------------------------------|
|  |                           | 2003                  | 2008                 |                                       |                                      |
| ANNUAL DOSE, TRUCK CREW (person-rem)         |                           |                       |                      |                                       |                                      |
| Radioactive                                  | 9.8                       | 18                    | 19.1                 | 57                                    | 4.5                                  |
| LLW  | 0.21                      | 0.68                  | 0.68                 | 1.1                                   | 0.41                                 |
| LLMW   | 2.6x10 <sup>-2</sup>      | 9.6x10 <sup>-2</sup>  | 9.6x10 <sup>-2</sup> | 9.6x10 <sup>-2</sup>                  | 9.6x10 <sup>-2</sup>                 |
| LLW (D&D)                                    | 0.21                      | 0.21                  | 0.21                 | 0.21                                  | 0.21                                 |
| Medical Isotopes Production                  | NA                        | 7.4                   | 7.4                  | 25.4                                  | 0.92                                 |
| ANNUAL DOSE, GENERAL POPULATION (person-rem) |                           |                       |                      |                                       |                                      |
| Radioactive                                  | 82.4                      | 151.7                 | 161.2                | 481.1                                 | 37.8                                 |
| LLW  | 0.60                      | 2                     | 2                    | 3.2                                   | 1.20                                 |
| LLMW   | 0.26                      | 0.88                  | 0.88                 | 0.88                                  | 0.88                                 |
| LLW (D&D)                                    | 0.60                      | 0.60                  | 0.60                 | 0.60                                  | 0.60                                 |
| Medical Isotopes Production                  | NA                        | 21.2                  | 21.2                 | 73                                    | 2.7                                  |
| ANNUAL LCFs                                  |                           |                       |                      |                                       |                                      |
| Radioactive                                  | 4.5x10 <sup>-2</sup>      | 8.3x10 <sup>-2</sup>  | 8.8x10 <sup>-2</sup> | 0.26                                  | 2.1x10 <sup>-2</sup>                 |
| LLW  | 3.8x10 <sup>-4</sup>      | 1.3x10 <sup>-3</sup>  | 1.3x10 <sup>-3</sup> | 2.0x10 <sup>-3</sup>                  | 7.6x10 <sup>-4</sup>                 |
| LLMW   | 1.4x10 <sup>-4</sup>      | 4.8x10 <sup>-4</sup>  | 4.9x10 <sup>-4</sup> | 4.8x10 <sup>-4</sup>                  | 4.8x10 <sup>-4</sup>                 |
| LLW (D&D)                                    | 3.8x10 <sup>-4</sup>      | 3.8x10 <sup>-4</sup>  | 3.8x10 <sup>-4</sup> | 3.8x10 <sup>-4</sup>                  | 3.8x10 <sup>-4</sup>                 |
| Medical Isotopes Production                  | NA                        | 1.4x10 <sup>-2</sup>  | 1.4x10 <sup>-2</sup> | 4.7x10 <sup>-2</sup>                  | 1.7x10 <sup>-3</sup>                 |
| TOTAL <sup>c</sup>                           | 4.6x10 <sup>-2</sup>      | 9.9x10 <sup>-2</sup>  | 0.1                  | 0.31                                  | 2.4x10 <sup>-2</sup>                 |

Sources: DOE 1996h, SNL 1992a, SNL/NM 1998a,

D&D: decontamination and decommissioning

LLMW: low-level mixed waste

LLW: low-level waste

LCFs: latent cancer fatalities

NA: not applicable

rem: Roentgen equivalent, man

<sup>a</sup> Material used or generated during normal operations

<sup>b</sup> The base year varies depending on information provided in the *Facilities and Safety Information Document* (FSID) (SNL/NM 1997b).

Typically, the base year is 1996 or 1997, as appropriate.

<sup>c</sup> Lifetime estimated LCFs from annual shipments

Note: Calculations using *RADTRAN 4* 1992 (SNL 1992a)



**Table G.4–4. Total Incident-Free Doses to Crew and Public from Special Project Shipments**

| MATERIAL TYPE                                | NO ACTION ALTERNATIVE |                      |                      | EXPANDED OPERATIONS ALTERNATIVE | REDUCED OPERATIONS ALTERNATIVE |
|--|-----------------------|----------------------|----------------------|---------------------------------|--------------------------------|
|  | BASE YEAR (1996)      | 2003                 | 2008                 |                                 |                                |
| ANNUAL DOSE, TRUCK CREW (person-rem)         |                       |                      |                      |                                 |                                |
| TRU/MTRU                                     | 0                     | 1.8x10 <sup>-3</sup> | 5.4x10 <sup>-3</sup> | 7.2x10 <sup>-3</sup>            | 3.6x10 <sup>-3</sup>           |
| TRU/MTRU (Legacy)                            | 0                     | 0                    | 3.6x10 <sup>-3</sup> | 3.6x10 <sup>-3</sup>            | 3.6x10 <sup>-3</sup>           |
| LLW (Legacy + ER)                            | 0                     | 0                    | 10.0                 | 10.0                            | 10.0                           |
| LLMW (Legacy + ER)                           | 0                     | 0                    | 3.4x10 <sup>-1</sup> | 3.4x10 <sup>-1</sup>            | 3.4x10 <sup>-1</sup>           |
| ANNUAL DOSE, GENERAL POPULATION (person-rem) |                       |                      |                      |                                 |                                |
| TRU/MTRU                                     | 0                     | 1.0x10 <sup>-2</sup> | 3.0x10 <sup>-2</sup> | 4.0x10 <sup>-2</sup>            | 2.0x10 <sup>-2</sup>           |
| TRU/MTRU (Legacy)                            | 0                     | 0                    | 2.0x10 <sup>-2</sup> | 2.0x10 <sup>-2</sup>            | 2.0x10 <sup>-2</sup>           |
| LLW (Legacy + ER)                            | 0                     | 0                    | 28.8                 | 28.8                            | 28.8                           |
| LLMW (Legacy + ER)                           | 0                     | 0                    | 3.4                  | 3.4                             | 3.4                            |
| ANNUAL LCFs                                  |                       |                      |                      |                                 |                                |
| TRU/MTRU                                     | 0                     | 5.7x10 <sup>-6</sup> | 1.7x10 <sup>-5</sup> | 2.3x10 <sup>-5</sup>            | 1.1x10 <sup>-5</sup>           |
| TRU/MTRU (Legacy)                            | 0                     | 0                    | 1.1x10 <sup>-5</sup> | 1.1x10 <sup>-5</sup>            | 1.1x10 <sup>-5</sup>           |
| LLW (Legacy + ER)                            | 0                     | 0                    | 1.8x10 <sup>-2</sup> | 1.8x10 <sup>-2</sup>            | 1.8x10 <sup>-2</sup>           |
| LLMW (Legacy + ER)                           | 0                     | 0                    | 1.8x10 <sup>-3</sup> | 1.8x10 <sup>-3</sup>            | 1.8x10 <sup>-3</sup>           |
| TOTAL <sup>a</sup>                           |                       | 5.7x10 <sup>-6</sup> | 2.0x10 <sup>-2</sup> | 2.0x10 <sup>-2</sup>            | 2.0x10 <sup>-2</sup>           |

Sources: DOE 1996h; SNL 1992a, SNL/NM 1998a

rem: Roentgen equivalent, man

ER: Environmental Restoration

LCFs: latent cancer fatalities

LLMW: low-level mixed waste

LLW: low-level waste

MTRU: mixed transuranic

TRU: transuranic

<sup>a</sup>Lifetime estimated LCFs from total special project shipments

Note: Calculations using RADTRAN 4 1992 (SNL 1992a)

### G.4.3 Accident Fatalities Risk

As with the incident-free risk analysis, the dose to the public due to accidental release was calculated for a single shipment of each material type to determine a bounding transportation impact. The unit shipment doses are presented in Table G.4–1. Table G.4–5 presents the annual doses to population from a radiological release due to a potential transportation accident supporting normal operations under each alternative. Table G.4–6 presents the doses to population from a radiological release due to a hypothetical transportation accident during special project shipments.

### G.4.4 Traffic Fatalities Risk

Traffic fatalities were estimated using unit-risk factors (risk per kilometer traveled) developed from national statistics for highway accident-related deaths

(SNL 1986). These nonradiological unit-risk factors are presented in Table G.4–7. The traffic fatalities per unit shipment are presented in Tables G.4–8 and G.4–9 for normal operations shipments and total special project shipments, respectively. The calculated lifetime traffic fatalities resulting from normal operations shipments for each alternative are presented in Table G.4–10. The calculated total traffic fatalities associated with special project shipments are presented in Table G.4–11.

### G.4.5 Vehicle Emissions Fatalities Risk

Nonradiological LCFs due to truck emissions (air pollutants) were evaluated based on unit-risk factors developed by SNL/NM (SNL/NM 1982). These nonradiological unit-risk factors are presented in Table G.4–7. Table G.4–12 presents the annual incident-free

**Table G.4–5. Doses to Population from Radiological Release Due to Transportation Accident During Normal Operations Shipments**

| MATERIAL TYPE                          | BASE YEAR <sup>a</sup> | NO ACTION ALTERNATIVE |                      | EXPANDED OPERATIONS ALTERNATIVE | REDUCED OPERATIONS ALTERNATIVE |
|--|------------------------|-----------------------|----------------------|---------------------------------|--------------------------------|
|  |                        | 2003                  | 2008                 |                                 |                                |
| ANNUAL DOSE TO POPULATION (person-rem) |                        |                       |                      |                                 |                                |
| Radioactive                            | 1.3x10 <sup>-2</sup>   | 2.4x10 <sup>-2</sup>  | 2.7x10 <sup>-2</sup> | 7.7x10 <sup>-2</sup>            | 6.0x10 <sup>-3</sup>           |
| LLW                                    | 2.3x10 <sup>-3</sup>   | 7.5x10 <sup>-3</sup>  | 7.5x10 <sup>-3</sup> | 1.2x10 <sup>-2</sup>            | 4.6x10 <sup>-3</sup>           |
| LLW (D&D)                              | 2.3x10 <sup>-3</sup>   | 2.3x10 <sup>-3</sup>  | 2.3x10 <sup>-3</sup> | 2.3x10 <sup>-3</sup>            | 2.3x10 <sup>-3</sup>           |
| LLMW                                   | 3.8x10 <sup>-5</sup>   | 1.1x10 <sup>-4</sup>  | 1.0x10 <sup>-4</sup> | 1.1x10 <sup>-4</sup>            | 1.1x10 <sup>-4</sup>           |
| Medical Isotopes Production            | NA                     | 1.5x10 <sup>-2</sup>  | 1.5x10 <sup>-2</sup> | 5.2x10 <sup>-2</sup>            | 1.9x10 <sup>-3</sup>           |
| ANNUAL LCFs                            |                        |                       |                      |                                 |                                |
| Radioactive                            | 6.6x10 <sup>-6</sup>   | 1.2x10 <sup>-5</sup>  | 1.3x10 <sup>-5</sup> | 3.9x10 <sup>-5</sup>            | 3.0x10 <sup>-6</sup>           |
| LLW                                    | 1.2x10 <sup>-6</sup>   | 3.8x10 <sup>-6</sup>  | 3.8x10 <sup>-6</sup> | 6.0x10 <sup>-6</sup>            | 2.3x10 <sup>-6</sup>           |
| LLW (D&D)                              | 1.2x10 <sup>-6</sup>   | 1.2x10 <sup>-6</sup>  | 1.2x10 <sup>-6</sup> | 1.2x10 <sup>-6</sup>            | 1.2x10 <sup>-6</sup>           |
| LLMW                                   | 1.7x10 <sup>-8</sup>   | 5.3x10 <sup>-8</sup>  | 5.3x10 <sup>-8</sup> | 5.3x10 <sup>-8</sup>            | 5.3x10 <sup>-8</sup>           |
| Medical Isotopes Production            | NA                     | 7.5x10 <sup>-6</sup>  | 7.5x10 <sup>-6</sup> | 3.0x10 <sup>-5</sup>            | 9.6x10 <sup>-7</sup>           |
| TOTAL RISK <sup>b</sup>                | 9.0x10 <sup>-6</sup>   | 2.5x10 <sup>-5</sup>  | 2.6x10 <sup>-5</sup> | 7.6x10 <sup>-5</sup>            | 7.5x10 <sup>-6</sup>           |

Sources: DOE 1996h, SNL 1992a, SNL/NM 1998a

D&amp;D: decontamination and decommissioning

LCFs: latent cancer fatalities

LLMW: low-level mixed waste

LLW: low-level waste

NA: not applicable

rem: Roentgen equivalent, man

<sup>a</sup> The base year varies depending on information provided in the *Facilities and Safety Information Document* (FSID) (SNL/NM 1997b). Typically, the base year is 1996 or 1997, as appropriate.<sup>b</sup> Lifetime estimated LCFs due to potential radiological accident

Note: Calculations using RADTRAN 4 1992 (SNL 1992a)

exposures due to truck emissions that could result in LCFs due to normal operations shipments. Table G.4–13 presents the estimated incident-free exposures due to truck emissions that could result in LCFs due to special project shipments.

#### G.4.6 Bounding Accident Scenario

The bounding transportation accident involves an explosion of a tractor-trailer containing 40,000 ft<sup>3</sup> of hydrogen. Appendix F provides detailed information regarding this bounding transportation accident. Additionally, Sections 5.3.8, 5.4.8, and 5.5.8 discuss radiological and chemical facility accidents.

**Table G.4–6. Dose to Population from Radiological Release Due to Transportation Accident During Special Project Shipments**

| MATERIAL TYPE                                | BASE YEAR<br>(1996) | NO ACTION ALTERNATIVE |                      | EXPANDED<br>OPERATIONS<br>ALTERNATIVE | REDUCED<br>OPERATIONS<br>ALTERNATIVE |
|--|---------------------|-----------------------|----------------------|---------------------------------------|--------------------------------------|
|  |                     | 2003                  | 2008                 |                                       |                                      |
| ANNUAL DOSE, GENERAL POPULATION (person-rem) |                     |                       |                      |                                       |                                      |
| TRU/MTRU                                     | 0                   | 3.4x10 <sup>-6</sup>  | 1.0x10 <sup>-5</sup> | 1.4x10 <sup>-5</sup>                  | 3.4x10 <sup>-6</sup>                 |
| TRU/MTRU (Legacy)                            | 0                   | 0                     | 6.8x10 <sup>-6</sup> | 6.8x10 <sup>-6</sup>                  | 6.8x10 <sup>-6</sup>                 |
| LLW (Legacy + ER)                            | 0                   | 0                     | 0.11                 | 0.11                                  | 0.11                                 |
| LLMW (Legacy + ER)                           | 0                   | 0                     | 4.4x10 <sup>-4</sup> | 4.4x10 <sup>-4</sup>                  | 4.4x10 <sup>-4</sup>                 |
| ANNUAL LCFs                                  |                     |                       |                      |                                       |                                      |
| TRU/MTRU                                     | 0                   | 1.7x10 <sup>-9</sup>  | 5.1x10 <sup>-9</sup> | 7.0x10 <sup>-9</sup>                  | 3.4x10 <sup>-9</sup>                 |
| TRU/MTRU (Legacy)                            | 0                   | 0                     | 3.4x10 <sup>-9</sup> | 3.4x10 <sup>-9</sup>                  | 3.4x10 <sup>-9</sup>                 |
| LLW (Legacy + ER)                            | 0                   | 0                     | 5.5x10 <sup>-5</sup> | 5.5x10 <sup>-5</sup>                  | 5.5x10 <sup>-5</sup>                 |
| LLMW (Legacy + ER)                           | 0                   | 0                     | 2.2x10 <sup>-7</sup> | 2.2x10 <sup>-7</sup>                  | 2.2x10 <sup>-7</sup>                 |
| TOTAL <sup>a</sup>                           |                     | 1.7x10 <sup>-9</sup>  | 5.5x10 <sup>-5</sup> | 5.5x10 <sup>-5</sup>                  | 5.5x10 <sup>-5</sup>                 |

Sources: DOE 1996h, SNL 1992a, SNL/NM 1998a

ER: Environmental Restoration

LCFs: latent cancer fatalities

LLMW: low-level mixed waste

LLW: low-level waste

MTRU: mixed transuranic

rem: Roentgen equivalent, man

TRU: transuranic

<sup>a</sup>Lifetime estimated LCFs from total special project shipments

Note: Calculations using RADTRAN 4 1992 (SNL 1992a)

**Table G.4–7. Nonradiological Unit-Risk Factors for Truck Transport**

| NORMAL                                   | RURAL                | SUBURBAN             | URBAN                |
|--|----------------------|----------------------|----------------------|
| <b>Nonoccupational Latent Cancers/km</b> | -                    | -                    | $1.0 \times 10^{-7}$ |
| <b>Nonoccupational Fatalities/km</b>     | $5.3 \times 10^{-8}$ | $1.3 \times 10^{-8}$ | $7.5 \times 10^{-9}$ |
| <b>Occupational Fatalities/km</b>        | $1.5 \times 10^{-8}$ | $3.7 \times 10^{-9}$ | $2.1 \times 10^{-9}$ |

Sources: SNL 1986, SNL/NM 1982

km: kilometer

**Table G.4–8. Transportation Traffic Fatalities Per Unit from Normal Operations Shipment by Alternative**

| MATERIAL TYPE  | BASE YEAR <sup>a</sup> | NO ACTION ALTERNATIVE |                      | EXPANDED OPERATIONS ALTERNATIVE | REDUCED OPERATIONS ALTERNATIVE |
|--|------------------------|-----------------------|----------------------|---------------------------------|--------------------------------|
|  |                        | 2003                  | 2008                 |                                 |                                |
| TRAFFIC FATALITIES, CREW AND GENERAL PUBLIC, PER SHIPMENT (ROUND TRIP) |                        |                       |                      |                                 |                                |
| Radioactive  | 3.5x10 <sup>-4</sup>   | 3.5x10 <sup>-4</sup>  | 3.5x10 <sup>-4</sup> | 3.5x10 <sup>-4</sup>            | 3.5x10 <sup>-4</sup>           |
| Chemical   | 2.1x10 <sup>-6</sup>   | 2.1x10 <sup>-6</sup>  | 2.1x10 <sup>-6</sup> | 2.1x10 <sup>-6</sup>            | 2.1x10 <sup>-6</sup>           |
| Explosive  | 2.9x10 <sup>-4</sup>   | 2.9x10 <sup>-4</sup>  | 2.9x10 <sup>-4</sup> | 2.9x10 <sup>-4</sup>            | 2.9x10 <sup>-4</sup>           |
| LLW  | 2.2x10 <sup>-4</sup>   | 2.2x10 <sup>-4</sup>  | 2.2x10 <sup>-4</sup> | 2.2x10 <sup>-4</sup>            | 2.2x10 <sup>-4</sup>           |
| LLMW (Receipt)   | 2.1x10 <sup>-4</sup>   | 2.1x10 <sup>-4</sup>  | 2.1x10 <sup>-4</sup> | 2.1x10 <sup>-4</sup>            | 2.1x10 <sup>-4</sup>           |
| LLMW (Shipment)  | 3.0x10 <sup>-4</sup>   | 3.0x10 <sup>-4</sup>  | 3.0x10 <sup>-4</sup> | 3.0x10 <sup>-4</sup>            | 3.0x10 <sup>-4</sup>           |
| Hazardous Waste  | 2.2x10 <sup>-4</sup>   | 2.2x10 <sup>-4</sup>  | 2.2x10 <sup>-4</sup> | 2.2x10 <sup>-4</sup>            | 2.2x10 <sup>-4</sup>           |
| Recyclable Hazardous Waste (California)                                | 1.5x10 <sup>-4</sup>   | 1.5x10 <sup>-4</sup>  | 1.5x10 <sup>-4</sup> | 1.5x10 <sup>-4</sup>            | 1.5x10 <sup>-4</sup>           |
| Recyclable Hazardous Waste (Local)                                     | 1.6x10 <sup>-6</sup>   | 1.6x10 <sup>-6</sup>  | 1.6x10 <sup>-6</sup> | 1.6x10 <sup>-6</sup>            | 1.6x10 <sup>-6</sup>           |
| Solid Waste  | 2.6x10 <sup>-6</sup>   | 2.6x10 <sup>-6</sup>  | 2.6x10 <sup>-6</sup> | 2.6x10 <sup>-6</sup>            | 2.6x10 <sup>-6</sup>           |
| D&D Hazardous Waste TSCA-PCBs  | 2.2x10 <sup>-4</sup>   | 2.2x10 <sup>-4</sup>  | 2.2x10 <sup>-4</sup> | 2.2x10 <sup>-4</sup>            | 2.2x10 <sup>-4</sup>           |
| D&D Hazardous Waste TSCA-Asbestos                                      | 2.2x10 <sup>-5</sup>   | 2.2x10 <sup>-5</sup>  | 2.2x10 <sup>-5</sup> | 2.2x10 <sup>-5</sup>            | 2.2x10 <sup>-5</sup>           |
| Biohazardous Waste   | 1.4x10 <sup>-4</sup>   | 1.4x10 <sup>-4</sup>  | 1.4x10 <sup>-4</sup> | 1.4x10 <sup>-4</sup>            | 1.4x10 <sup>-4</sup>           |
| Recyclable D&D Hazardous Waste   | 1.6x10 <sup>-6</sup>   | 1.6x10 <sup>-6</sup>  | 1.6x10 <sup>-6</sup> | 1.6x10 <sup>-6</sup>            | 1.6x10 <sup>-6</sup>           |
| Recyclable Nonhazardous Solid Waste                                    | 1.6x10 <sup>-6</sup>   | 1.6x10 <sup>-6</sup>  | 1.6x10 <sup>-6</sup> | 1.6x10 <sup>-6</sup>            | 1.6x10 <sup>-4</sup>           |
| Nonhazardous Landscaping Waste   | NA                     | 2.6x10 <sup>-6</sup>  | 2.6x10 <sup>-6</sup> | 2.6x10 <sup>-6</sup>            | 2.6x10 <sup>-6</sup>           |
| Construction and Demolition Solid Waste                                | NA                     | 2.6x10 <sup>-6</sup>  | 2.6x10 <sup>-6</sup> | 2.6x10 <sup>-6</sup>            | 2.6x10 <sup>-6</sup>           |
| RCRA Hazardous Waste (Receipt)   | 6.7x10 <sup>-7</sup>   | 6.7x10 <sup>-7</sup>  | 6.7x10 <sup>-7</sup> | 6.7x10 <sup>-7</sup>            | 6.7x10 <sup>-7</sup>           |
| LLW (D&D)  | 2.2x10 <sup>-4</sup>   | 2.2x10 <sup>-4</sup>  | 2.2x10 <sup>-4</sup> | 2.2x10 <sup>-4</sup>            | 2.2x10 <sup>-4</sup>           |

Sources: SNL 1986, 1992a; SNL/NM 1982

D&amp;D: decontamination and decommissioning

LLMW: low-level mixed waste

LLW: low-level waste

PCB: polychlorinated biphenyl

RCRA: Resource Conservation and Recovery Act

TSCA: Toxic Substances Control Act

<sup>a</sup>The base year varies depending on information provided in the Facilities and Safety Information Document (FSID) (SNL/NM 1997b). Typically, the base year is 1996 or 1997, as appropriate.

**Table G.4–9. Transportation Traffic Fatalities Per Unit  
Shipment from Total Special Project Shipments**

| MATERIAL TYPE                        | BASE<br>YEAR<br>(1996) | NO ACTION ALTERNATIVE |                      | EXPANDED<br>OPERATIONS<br>ALTERNATIVE | REDUCED<br>OPERATIONS<br>ALTERNATIVE |
|--------------------------------------|------------------------|-----------------------|----------------------|---------------------------------------|--------------------------------------|
|                                      |                        | 2003                  | 2008                 |                                       |                                      |
| <i>TRU/MTRU</i>                      | 0                      | $1.9 \times 10^{-5}$  | $1.9 \times 10^{-5}$ | $1.9 \times 10^{-5}$                  | $1.9 \times 10^{-5}$                 |
| <i>TRU/MTRU (Legacy)</i>             | 0                      | 0                     | $1.9 \times 10^{-5}$ | $1.9 \times 10^{-5}$                  | $1.9 \times 10^{-5}$                 |
| <i>LLW (Legacy)</i>                  | 0                      | 0                     | $2.2 \times 10^{-4}$ | $2.2 \times 10^{-4}$                  | $2.2 \times 10^{-4}$                 |
| <i>LLMW (Legacy)</i>                 | 0                      | 0                     | $3.0 \times 10^{-4}$ | $3.0 \times 10^{-4}$                  | $3.0 \times 10^{-4}$                 |
| <i>LLW (ER)</i>                      | 0                      | 0                     | $2.2 \times 10^{-4}$ | $2.2 \times 10^{-4}$                  | $2.2 \times 10^{-4}$                 |
| <i>LLMW (ER)</i>                     | 0                      | 0                     | $3.0 \times 10^{-4}$ | $3.0 \times 10^{-4}$                  | $3.0 \times 10^{-4}$                 |
| <i>Hazardous Waste (ER)</i>          | 0                      | 0                     | $2.2 \times 10^{-4}$ | $2.2 \times 10^{-4}$                  | $2.2 \times 10^{-4}$                 |
| <i>Nonhazardous Solid Waste (ER)</i> | 0                      | 0                     | $2.6 \times 10^{-6}$ | $2.6 \times 10^{-6}$                  | $2.6 \times 10^{-6}$                 |

Sources: SNL 1986, 1992a; SNL/NM 1982

ER: Environmental Restoration

LLMW: low-level mixed waste

LLW: low-level waste

MTRU: mixed transuranic

TRU: transuranic

**Table G.4–10. Transportation Traffic Lifetime Fatalities for Normal Operations from Annual Shipments by Alternative**

| MATERIAL TYPE  | BASE YEAR <sup>a</sup> | NO ACTION ALTERNATIVE |                      | EXPANDED OPERATIONS ALTERNATIVE | REDUCED OPERATIONS ALTERNATIVE |
|--|------------------------|-----------------------|----------------------|---------------------------------|--------------------------------|
|  |                        | 2003                  | 2008                 |                                 |                                |
| TRAFFIC FATALITIES, CREW AND GENERAL PUBLIC, PER SHIPMENT (ROUND TRIP) |                        |                       |                      |                                 |                                |
| Radioactive  | 0.11                   | 0.20                  | 0.21                 | 0.62                            | 4.9x10 <sup>-2</sup>           |
| Explosive  | 8.8x10 <sup>-2</sup>   | 0.16                  | 0.17                 | 0.51                            | 4.0x10 <sup>-2</sup>           |
| Chemical   | 5.8x10 <sup>-3</sup>   | 5.8x10 <sup>-3</sup>  | 5.8x10 <sup>-3</sup> | 5.8x10 <sup>-3</sup>            | 5.8x10 <sup>-3</sup>           |
| Medical Isotopes Production  | NA                     | 6.0x10 <sup>-3</sup>  | 6.0x10 <sup>-3</sup> | 2.1x10 <sup>-2</sup>            | 7.7x10 <sup>-4</sup>           |
| LLW  | 8.8x10 <sup>-4</sup>   | 2.9x10 <sup>-3</sup>  | 2.9x10 <sup>-3</sup> | 4.6x10 <sup>-3</sup>            | 1.8x10 <sup>-3</sup>           |
| LLMW (Receipt)   | 0                      | 2.1x10 <sup>-4</sup>  | 2.1x10 <sup>-4</sup> | 2.1x10 <sup>-4</sup>            | 2.1x10 <sup>-4</sup>           |
| LLMW (Shipment)  | 3.0x10 <sup>-4</sup>   | 9.0x10 <sup>-4</sup>  | 9.0x10 <sup>-4</sup> | 9.0x10 <sup>-4</sup>            | 9.0x10 <sup>-4</sup>           |
| Hazardous Waste  | 1.4x10 <sup>-2</sup>   | 1.8x10 <sup>-2</sup>  | 1.9x10 <sup>-2</sup> | 2.5x10 <sup>-2</sup>            | 1.3x10 <sup>-2</sup>           |
| Recyclable Hazardous Waste (California)                                | 3.0x10 <sup>-4</sup>   | 4.5x10 <sup>-4</sup>  | 4.5x10 <sup>-4</sup> | 6.0x10 <sup>-4</sup>            | 3.0x10 <sup>-4</sup>           |
| Recyclable Hazardous Waste (Local)                                     | 9.6x10 <sup>-6</sup>   | 1.3x10 <sup>-5</sup>  | 1.3x10 <sup>-5</sup> | 1.8x10 <sup>-5</sup>            | 9.6x10 <sup>-6</sup>           |
| Solid Waste  | 1.3x10 <sup>-4</sup>   | 1.3x10 <sup>-4</sup>  | 1.3x10 <sup>-4</sup> | 1.3x10 <sup>-4</sup>            | 1.3x10 <sup>-4</sup>           |
| D&D Hazardous Waste TSCA-PCBs  | 2.2x10 <sup>-4</sup>   | 2.2x10 <sup>-4</sup>  | 2.2x10 <sup>-4</sup> | 2.2x10 <sup>-4</sup>            | 2.2x10 <sup>-4</sup>           |
| D&D Hazardous Waste TSCA-Asbestos                                      | 3.1x10 <sup>-4</sup>   | 3.1x10 <sup>-4</sup>  | 3.1x10 <sup>-4</sup> | 3.1x10 <sup>-4</sup>            | 3.1x10 <sup>-4</sup>           |
| Biohazardous Waste   | 1.4x10 <sup>-4</sup>   | 1.4x10 <sup>-4</sup>  | 1.4x10 <sup>-4</sup> | 1.4x10 <sup>-4</sup>            | 1.4x10 <sup>-4</sup>           |
| Recyclable D&D Hazardous Waste   | 3.5x10 <sup>-5</sup>   | 3.5x10 <sup>-5</sup>  | 3.5x10 <sup>-5</sup> | 3.5x10 <sup>-5</sup>            | 3.5x10 <sup>-5</sup>           |
| Recyclable Nonhazardous Solid Waste                                    | 1.2x10 <sup>-4</sup>   | 1.2x10 <sup>-4</sup>  | 1.2x10 <sup>-4</sup> | 1.2x10 <sup>-4</sup>            | 1.2x10 <sup>-4</sup>           |
| Nonhazardous Landscaping Waste   | NA                     | 3.7x10 <sup>-4</sup>  | 3.7x10 <sup>-4</sup> | 3.7x10 <sup>-4</sup>            | 3.7x10 <sup>-4</sup>           |
| Construction and Demolition Solid Waste                                | NA                     | 1.6x10 <sup>-3</sup>  | 1.6x10 <sup>-3</sup> | 1.6x10 <sup>-3</sup>            | 1.6x10 <sup>-3</sup>           |
| RCRA Hazardous Waste (Receipt)   | 8.0x10 <sup>-6</sup>   | 1.7x10 <sup>-5</sup>  | 1.7x10 <sup>-5</sup> | 1.7x10 <sup>-5</sup>            | 1.7x10 <sup>-5</sup>           |
| LLW (D&D)  | 8.8x10 <sup>-4</sup>   | 8.8x10 <sup>-4</sup>  | 8.8x10 <sup>-4</sup> | 8.8x10 <sup>-4</sup>            | 8.8x10 <sup>-4</sup>           |
| TOTAL <sup>b</sup>   | 0.22                   | 0.40                  | 0.42                 | 1.2                             | 0.11                           |

Sources: DOE 1997i, SNL 1986, 1992a; SNL/NM 1982, 1997d, 1998a

D&amp;D: decontamination and decommissioning

LLMW: low-level mixed waste

LLW: low-level waste

PCB: polychlorinated biphenyl

RCRA: Resource Conservation and Recovery Act

rem: Roentgen equivalent, man

TSCA: Toxic Substances Control Act

<sup>a</sup> The base year varies depending on information provided in the *Facilities and Safety Information Document (FSID)* (SNL/NM 1997b). Typically, the base year is 1996 or 1997, as appropriate.<sup>b</sup> Lifetime estimated fatalities from annual shipments

Note: Calculations were completed using RADTRAN 4 1992 (SNL 1992b)



**Table G.4–11. Transportation Traffic Fatalities  
from Total Special Project Shipments**

| MATERIAL TYPE                   | BASE YEAR<br>(1996) | NO ACTION ALTERNATIVE |  | EXPANDED<br>OPERATIONS<br>ALTERNATIVE  | REDUCED<br>OPERATIONS<br>ALTERNATIVE   |
|---------------------------------|---------------------|-----------------------|--|--|--|
|                                 |                     | 2003                  | 2008                                   |  |  |
| <i>TRU/MTRU</i>                 | 0                   | $1.9 \times 10^{-5}$  | $5.7 \times 10^{-5}$                   | $7.6 \times 10^{-5}$                   | $3.8 \times 10^{-5}$                   |
| <i>TRU/MTRU (Legacy)</i>        | 0                   | 0                     | $3.8 \times 10^{-5}$                   | $3.8 \times 10^{-5}$                   | $3.8 \times 10^{-5}$                   |
| <i>LLW (Legacy)</i>             | 0                   | 0                     | $1.2 \times 10^{-2}$                   | $1.2 \times 10^{-2}$                   | $1.2 \times 10^{-2}$                   |
| <i>LLMW (Legacy)</i>            | 0                   | 0                     | $2.4 \times 10^{-3}$                   | $2.4 \times 10^{-3}$                   | $2.4 \times 10^{-3}$                   |
| <i>LLW (ER)</i>                 | 0                   | 0                     | $3.0 \times 10^{-2}$                   | $3.0 \times 10^{-2}$                   | $3.0 \times 10^{-2}$                   |
| <i>LLMW (ER)</i>                | 0                   | 0                     | $1.5 \times 10^{-3}$                   | $1.5 \times 10^{-3}$                   | $1.5 \times 10^{-3}$                   |
| <i>Hazardous Waste (ER)</i>     | 0                   | 0                     | $2.5 \times 10^{-2}$                   | $2.5 \times 10^{-2}$                   | $2.5 \times 10^{-2}$                   |
| <i>Solid Waste (ER)</i>         | 0                   | 0                     | $2.3 \times 10^{-5}$                   | $2.3 \times 10^{-5}$                   | $2.3 \times 10^{-5}$                   |
| <b><i>TOTAL<sup>a</sup></i></b> |                     |                       | <b><math>7.1 \times 10^{-2}</math></b> | <b><math>7.1 \times 10^{-2}</math></b> | <b><math>7.1 \times 10^{-2}</math></b> |

Sources: SNL 1986, 1992a; SNL/NM 1982, 1998a

ER: Environmental Restoration

LLMW: low-level mixed waste

LLW: low-level waste

MTRU: mixed transuranic

TRU: transuranic

<sup>a</sup>Lifetime estimated fatalities from annual shipments

Note: Calculations were completed using RADTRAN 4 1992 (SNL 1992b)

**Table G.4–12. Annual Incident-Free Exposures Due to Truck Emissions from Normal Operations Shipments**

| MATERIAL TYPE                                      | UNIT RISK<br>FACTOR<br>PER<br>URBAN<br>KILOMETER | TRUCK<br>DISTANCE<br>TRAVELED<br>PER<br>SHIPMENT<br>(km) | LCFs PER<br>SHIPMENT<br>FOR<br>ROUND<br>TRIP | TOTAL LCFs<br>FOR BASE<br>YEAR<br>SHIPMENTS<br>(TYPICALLY<br>1996) | TOTAL LCFs<br>FOR<br>NO ACTION<br>ALTERNATIVE |                      | TOTAL LCFs<br>FOR<br>EXPANDED<br>OPERATIONS<br>ALTERNATIVE | TOTAL LCFs<br>FOR<br>REDUCED<br>OPERATIONS<br>ALTERNATIVE |
|--|--|--|--|--|---|----------------------|--|---|
|  |  |  |  |  | 2003  | 2008                 |  |   |
| <i>Radioactive</i>                                 | $1.0 \times 10^{-7}$                             | 73   | $1.5 \times 10^{-5}$                         | $4.6 \times 10^{-3}$   | $8.4 \times 10^{-3}$                          | $9.0 \times 10^{-3}$ | $2.8 \times 10^{-2}$                                       | $2.1 \times 10^{-3}$                                      |
| <i>Chemical</i>                                    | $1.0 \times 10^{-7}$                             | 8.0  | $1.6 \times 10^{-6}$                         | $4.4 \times 10^{-3}$   | $4.4 \times 10^{-3}$                          | $4.4 \times 10^{-3}$ | $4.4 \times 10^{-3}$                                       | $4.4 \times 10^{-3}$                                      |
| <i>Explosive</i>                                   | $1.0 \times 10^{-7}$                             | 48.0   | $9.6 \times 10^{-6}$                         | $2.9 \times 10^{-3}$   | $5.3 \times 10^{-3}$                          | $5.7 \times 10^{-3}$ | $1.7 \times 10^{-2}$                                       | $1.3 \times 10^{-3}$                                      |
| <i>LLW</i>   | $1.0 \times 10^{-7}$                             | 33.0   | $6.6 \times 10^{-6}$                         | $2.6 \times 10^{-5}$   | $8.6 \times 10^{-5}$                          | $8.6 \times 10^{-5}$ | $1.4 \times 10^{-4}$                                       | $5.3 \times 10^{-5}$                                      |
| <i>LLMW (Receipt)</i>                              | $1.0 \times 10^{-7}$                             | 35.6   | $7.1 \times 10^{-6}$                         | 0  | $7.1 \times 10^{-6}$                          | $7.1 \times 10^{-6}$ | $7.1 \times 10^{-6}$                                       | $7.1 \times 10^{-6}$                                      |
| <i>LLMW (Shipment)</i>                             | $1.0 \times 10^{-7}$                             | 40.6   | $8.1 \times 10^{-6}$                         | $8.1 \times 10^{-6}$   | $2.4 \times 10^{-5}$                          | $2.4 \times 10^{-5}$ | $2.4 \times 10^{-5}$                                       | $2.4 \times 10^{-5}$                                      |
| <i>Medical Isotopes<br/>Production</i>             | -  | -  | -  | NA   | $2.0 \times 10^{-3}$                          | $2.0 \times 10^{-3}$ | $1.0 \times 10^{-2}$                                       | $3.5 \times 10^{-4}$                                      |
| <i>Hazardous Waste</i>                             | $1.0 \times 10^{-7}$                             | 33.0   | $6.6 \times 10^{-6}$                         | $4.2 \times 10^{-4}$   | $5.3 \times 10^{-4}$                          | $5.5 \times 10^{-4}$ | $7.4 \times 10^{-4}$                                       | $3.8 \times 10^{-4}$                                      |
| <i>Recyclable Hazardous<br/>Waste (California)</i> | $1.0 \times 10^{-7}$                             | 23.0   | $4.6 \times 10^{-6}$                         | $9.2 \times 10^{-6}$   | $1.4 \times 10^{-5}$                          | $1.4 \times 10^{-5}$ | $1.8 \times 10^{-5}$                                       | $9.2 \times 10^{-6}$                                      |
| <i>Recyclable Hazardous<br/>Waste (Local)</i>      | $1.0 \times 10^{-7}$                             | 6.4  | $1.3 \times 10^{-6}$                         | $7.8 \times 10^{-6}$   | $1.0 \times 10^{-5}$                          | $1.0 \times 10^{-5}$ | $4.4 \times 10^{-5}$                                       | $7.8 \times 10^{-6}$                                      |
| <i>Solid Waste</i>                                 | $1.0 \times 10^{-7}$                             | 10.0   | $2.0 \times 10^{-6}$                         | $1.0 \times 10^{-4}$   | $1.0 \times 10^{-4}$                          | $1.0 \times 10^{-4}$ | $1.0 \times 10^{-4}$                                       | $1.0 \times 10^{-4}$                                      |
| <i>D&amp;D hazardous waste<br/>TSCA-PCBs</i>       | $1.0 \times 10^{-7}$                             | 33.0   | $6.6 \times 10^{-6}$                         | $6.6 \times 10^{-6}$   | $6.6 \times 10^{-6}$                          | $6.6 \times 10^{-6}$ | $6.6 \times 10^{-6}$                                       | $6.6 \times 10^{-6}$                                      |
| <i>D&amp;D Hazardous Waste<br/>TSCA-Asbestos</i>   | $1.0 \times 10^{-7}$                             | 10.0   | $2.0 \times 10^{-6}$                         | $2.8 \times 10^{-5}$   | $2.8 \times 10^{-5}$                          | $2.8 \times 10^{-5}$ | $2.8 \times 10^{-5}$                                       | $2.8 \times 10^{-5}$                                      |
| <i>Biohazardous Waste</i>                          | $1.0 \times 10^{-7}$                             | 24.0   | $4.8 \times 10^{-6}$                         | $4.8 \times 10^{-6}$   | $4.8 \times 10^{-6}$                          | $4.8 \times 10^{-6}$ | $4.8 \times 10^{-6}$                                       | $4.8 \times 10^{-6}$                                      |
| <i>Recyclable D&amp;D<br/>Hazardous Waste</i>      | $1.0 \times 10^{-7}$                             | 6.4  | $1.3 \times 10^{-6}$                         | $2.9 \times 10^{-5}$   | $2.9 \times 10^{-5}$                          | $2.9 \times 10^{-5}$ | $2.9 \times 10^{-5}$                                       | $2.9 \times 10^{-5}$                                      |

**Table G.4–12. Annual Incident-Free Exposures Due to Truck Emissions from Normal Operations Shipments (concluded)**

| MATERIAL TYPE                                      | UNIT RISK<br>FACTOR<br>PER<br>URBAN<br>KILOMETER | TRUCK<br>DISTANCE<br>TRAVELED<br>PER<br>SHIPMENT<br>(km) | LCFs PER<br>SHIPMENT<br>FOR<br>ROUND<br>TRIP | TOTAL LCFs<br>FOR BASE<br>YEAR<br>SHIPMENTS<br>(TYPICALLY<br>1996) | TOTAL LCFs<br>FOR<br>NO ACTION<br>ALTERNATIVE |  | TOTAL LCFs<br>FOR<br>EXPANDED<br>OPERATIONS<br>ALTERNATIVE | TOTAL LCFs<br>FOR<br>REDUCED<br>OPERATIONS<br>ALTERNATIVE |
|--|--|--|--|--|---|--|--|---|
|  |  |  |  |  | 2003  | 2008                                   |  |   |
| <i>Recyclable<br/>Nonhazardous Solid<br/>Waste</i> | $1.0 \times 10^{-7}$                             | 6.4  | $1.3 \times 10^{-6}$                         | $1.0 \times 10^{-4}$   | $1.0 \times 10^{-4}$                          | $1.0 \times 10^{-4}$                   | $1.0 \times 10^{-4}$                                       | $1.0 \times 10^{-4}$                                      |
| <i>Nonhazardous<br/>Landscaping Waste</i>          | $1.0 \times 10^{-7}$                             | 10   | $2.0 \times 10^{-6}$                         | NA   | $2.8 \times 10^{-4}$                          | $2.8 \times 10^{-4}$                   | $2.8 \times 10^{-4}$                                       | $2.8 \times 10^{-4}$                                      |
| <i>Construction and<br/>Demolition Solid Waste</i> | $1.0 \times 10^{-7}$                             | 10   | $2.0 \times 10^{-6}$                         | NA   | $1.2 \times 10^{-3}$                          | $1.2 \times 10^{-3}$                   | $1.2 \times 10^{-3}$                                       | $1.2 \times 10^{-3}$                                      |
| <i>RCRA Hazardous Waste<br/>(Receipt)</i>          | $1.0 \times 10^{-7}$                             | 3  | $6.0 \times 10^{-7}$                         | $7.2 \times 10^{-6}$   | $1.5 \times 10^{-5}$                          | $1.5 \times 10^{-5}$                   | $1.5 \times 10^{-5}$                                       | $1.5 \times 10^{-5}$                                      |
| <i>LLW (D&amp;D)</i>                               | $1.0 \times 10^{-7}$                             | 33   | $6.6 \times 10^{-6}$                         | $2.6 \times 10^{-5}$   | $2.6 \times 10^{-5}$                          | $2.6 \times 10^{-5}$                   | $2.6 \times 10^{-5}$                                       | $2.6 \times 10^{-5}$                                      |
| <b>TOTAL<sup>a</sup></b>                           |  |  |  | <b><math>1.33 \times 10^{-2}</math></b>                            | <b><math>2.3 \times 10^{-2}</math></b>        | <b><math>2.4 \times 10^{-2}</math></b> | <b><math>6.2 \times 10^{-2}</math></b>                     | <b><math>1.1 \times 10^{-2}</math></b>                    |

Sources: SNL 1992a, SNL/NM 1982, 1998a

D&amp;D: decontamination and decommissioning

km: kilometer

LCFs: latent cancer fatalities

LLMW: low-level mixed waste

LLW: low-level waste

PCB: polychlorinated biphenyl

RCRA: Resource Conservation and Recovery Act

TSCA: Toxic Substance Control Act

<sup>a</sup> Lifetime estimated total LCFs from annual shipments

**Table G.4–13. Total Incident-Free Exposures Due to Truck Emissions from Special Project Shipments**

| MATERIAL TYPE                            | UNIT RISK<br>FACTOR<br>PER<br>URBAN<br>KILOMETER | TRUCK<br>DISTANCE<br>TRAVELED<br>PER<br>SHIPMENT<br>(km) | LCFs PER<br>SHIPMENT<br>FOR<br>ROUND TRIP | TOTAL LCFs<br>FOR BASE<br>YEAR<br>SHIPMENTS<br>(TYPICALLY<br>1996) | TOTAL LCFs FOR<br>NO ACTION<br>ALTERNATIVE |  | TOTAL LCFs<br>FOR<br>EXPANDED<br>OPERATIONS<br>ALTERNATIVE | TOTAL LCFs<br>FOR<br>REDUCED<br>OPERATIONS<br>ALTERNATIVE |
|--|--|--|---|--|--|--|--|---|
|  |  |  |   |  | 2003                                       | 2008                                   |  |   |
| <i>TRU/MTRU</i>                          | $1.0 \times 10^{-7}$                             | 8.4  | $1.7 \times 10^{-6}$                      | 0  | $1.7 \times 10^{-6}$                       | $5.1 \times 10^{-6}$                   | $6.8 \times 10^{-6}$                                       | $3.4 \times 10^{-6}$                                      |
| <i>TRU/MTRU (Legacy)</i>                 | $1.0 \times 10^{-7}$                             | 8.4  | $1.7 \times 10^{-6}$                      | 0  | 0  | $3.4 \times 10^{-6}$                   | $3.4 \times 10^{-6}$                                       | $3.4 \times 10^{-6}$                                      |
| <i>LLW (Legacy)</i>                      | $1.0 \times 10^{-7}$                             | 33   | $6.6 \times 10^{-6}$                      | 0  | 0  | $3.7 \times 10^{-4}$                   | $3.7 \times 10^{-4}$                                       | $3.7 \times 10^{-4}$                                      |
| <i>LLMW (Legacy)</i>                     | $1.0 \times 10^{-7}$                             | 40.6   | $8.1 \times 10^{-6}$                      | 0  | 0  | $6.5 \times 10^{-5}$                   | $6.5 \times 10^{-5}$                                       | $6.5 \times 10^{-5}$                                      |
| <i>LLW (ER)</i>                          | $1.0 \times 10^{-7}$                             | 33   | $6.6 \times 10^{-6}$                      | 0  | 0  | $9.0 \times 10^{-4}$                   | $9.0 \times 10^{-4}$                                       | $9.0 \times 10^{-4}$                                      |
| <i>LLMW (ER)</i>                         | $1.0 \times 10^{-7}$                             | 40.6   | $8.1 \times 10^{-6}$                      | 0  | 0  | $4.1 \times 10^{-5}$                   | $4.1 \times 10^{-5}$                                       | $4.1 \times 10^{-5}$                                      |
| <i>Hazardous Waste (ER)</i>              | $1.0 \times 10^{-7}$                             | 33   | $6.6 \times 10^{-6}$                      | 0  | 0  | $7.5 \times 10^{-4}$                   | $7.5 \times 10^{-4}$                                       | $7.5 \times 10^{-4}$                                      |
| <i>Nonhazardous<br/>Solid Waste (ER)</i> | $1.0 \times 10^{-7}$                             | 10   | $2.0 \times 10^{-6}$                      | 0  | 0  | $1.8 \times 10^{-5}$                   | $1.8 \times 10^{-5}$                                       | $1.8 \times 10^{-5}$                                      |
| <b><i>TOTAL<sup>a</sup></i></b>          |  |  |   |  | <b><math>1.7 \times 10^{-6}</math></b>     | <b><math>2.1 \times 10^{-3}</math></b> | <b><math>2.1 \times 10^{-3}</math></b>                     | <b><math>2.1 \times 10^{-3}</math></b>                    |

Sources: SNL 1992a, SNL/NM 1982, 1998a

ER: Environmental Restoration

km: kilometer

LCFs: latent cancer fatalities

LLMW: low-level mixed waste

LLW: low-level waste

MTRU: mixed transuranic

TRU: transuranic

<sup>a</sup> Lifetime estimated LCFs from total special project shipments Summary of Transportation Risk-Calculations

## G.5 SUMMARY OF TRANSPORTATION RISK CALCULATIONS

Table G.5–1 presents a summary of overall transportation impacts evaluated in terms of fatalities due to annual shipments for the SNL/NM operations for the base year and under each alternative. The major contributor to the overall impact would be highway

traffic fatalities. Table G.5–2 presents the total transportation impacts evaluated in terms of fatalities due to total special project shipments. These impacts, when combined with annual normal operations shipments, would have minimal effect on overall transportation impacts. The impacts of annual shipments supporting normal operations would be much higher than those of special project shipments.

**Table G.5–1. Summary of Overall Lifetime Estimated Transportation Impacts Due to Normal Operations (Fatalities per Annual Shipments)**

| TYPE OF IMPACT                     | BASE YEAR (1996)     | NO ACTION ALTERNATIVE |                      | EXPANDED OPERATIONS ALTERNATIVE | REDUCED OPERATIONS ALTERNATIVE |
|------------------------------------|----------------------|-----------------------|----------------------|---------------------------------|--------------------------------|
|                                    |                      | 2003                  | 2008                 |                                 |                                |
| <i>Radiological Incident-Free</i>  | $4.6 \times 10^{-2}$ | $9.9 \times 10^{-2}$  | 0.1                  | 0.31                            | $2.4 \times 10^{-2}$           |
| <i>Radiological Accident</i>       | $9.0 \times 10^{-6}$ | $2.5 \times 10^{-5}$  | $2.6 \times 10^{-5}$ | $7.6 \times 10^{-5}$            | $7.5 \times 10^{-6}$           |
| <i>Traffic Fatalities</i>          | 0.22                 | 0.40                  | 0.42                 | 1.2                             | 0.11                           |
| <i>LCFs Due to Truck Emissions</i> | $1.4 \times 10^{-2}$ | $2.3 \times 10^{-2}$  | $2.6 \times 10^{-2}$ | $6.2 \times 10^{-2}$            | $1.1 \times 10^{-2}$           |

Sources: SNL 1986, 1992a; SNL/NM 1982, 1998a

LCFs: latent cancer fatalities

Note: Calculations using RADTRAN 4 1992 (SNL 1992a)

**Table G.5–2. Overall Lifetime Estimated Transportation Impacts Due to Special Project Operations (Fatalities per Annual Shipments)**

| TYPE OF IMPACT                     | BASE YEAR (1996) | NO ACTION ALTERNATIVE |                      | EXPANDED OPERATIONS ALTERNATIVE | REDUCED OPERATIONS ALTERNATIVE |
|------------------------------------|------------------|-----------------------|----------------------|---------------------------------|--------------------------------|
|                                    |                  | 2003                  | 2008                 |                                 |                                |
| <i>Radiological Incident-Free</i>  | 0                | $5.7 \times 10^{-6}$  | $2.0 \times 10^{-2}$ | $2.0 \times 10^{-2}$            | $2.0 \times 10^{-2}$           |
| <i>Radiological Accident</i>       | 0                | 0                     | $5.5 \times 10^{-5}$ | $5.5 \times 10^{-5}$            | $5.5 \times 10^{-5}$           |
| <i>Traffic Fatalities</i>          | 0                | 0                     | $6.9 \times 10^{-2}$ | $6.9 \times 10^{-2}$            | $6.9 \times 10^{-2}$           |
| <i>LCFs Due to Truck Emissions</i> | 0                | 0                     | $2.1 \times 10^{-3}$ | $2.1 \times 10^{-3}$            | $2.1 \times 10^{-3}$           |

Sources: SNL 1986, 1992a; SNL/NM 1982, 1998a

LCFs: latent cancer fatalities

Note: Calculations using RADTRAN 4 1992 (SNL 1992a)

## **G.6 TRANSPORTATION ROUTE SCREENING AND INCIDENT-FREE IMPACTS ANALYSIS**

### **G.6.1 Transportation Route Screening**

SNL/NM operations rely on the transportation of material and wastes throughout much of the U.S. The estimated quantities of material and wastes were projected based on the levels of activities presented in the SNL/NM facility source documents (SNL/NM 1998a). Appendix A contains the information regarding SNL/NM material inventories. Waste generation projections and wastes currently in storage are presented in Appendix H.

The transportation impacts associated with material and wastes have been calculated. Due to uncertainties in the number of projected shipments, receipts, and possible transportation routes, a bounding analysis was completed using representative routes for each material and waste. To select a representative route, a screening was performed that included reviewing SNL/NM transportation records for each material type and waste category. [Table G.6–1](#) presents the sites and corresponding parameters considered in selecting representative routes. The selection was made based on the location with the largest number of shipments/receipts, the longest transportation route, and the highest population distribution along the route.

### **G.6.2 Incident-Free Impacts Analysis**

The incident-free impacts associated with radioactive material and wastes have been calculated. Due to uncertainties in the quantities and radioactivity of projected shipments and receipts, a bounding analysis was completed using the maximum Transport Index (TI) value allowed by regulation. The *RADTRAN 4* model limits TI-related calculations based on package size. A package 1-m in size carries a TI value of 16, while a 5-m-size package carries a TI value of 13. The SNL/NM SWEIS evaluated a 1-m-size package, 1 package per shipment, a TI value of 16 per shipment, and a stop time of 0.011 hr/km. Further, the data presented in [Table G.6–1](#) for radioactive materials and radioactive wastes were used in the *RADTRAN 4* modeling.

Calculations using TI values of 5, 8, and 13 were completed to illustrate the bounding affect of the 16 TI value. [Table G.6–2](#) compares the incident-free impact calculation for a radioactive material shipment to Mountaintop, Pennsylvania, with variations in TI. The table shows that the doses to the crew and the public (off-link, on-link, and stop) are linearly proportional to the TI value and decrease as the TI value decreases.

The 16 TI value is conservative. The incident-free impacts for the transport of radioactive materials would be much lower than the highway traffic fatalities (see [Section G.4](#)).



**Table G.6–1. SNL/NM Shipping Locations, Material Type, Route Characteristics, and Total Distance**

| SHIPMENT FROM SNL/NM TO LOCATION<br>(MATERIAL TYPE) | ROUTE CHARACTERISTICS |          |         | TOTAL<br>DISTANCE<br>(km) |
|---|-----------------------|----------|---------|---------------------------|
|   | RURAL                 | SUBURBAN | URBAN   |                           |
| MOUNTAINTOP, PA (RADIOACTIVE MATERIALS)             |                       |          |         |                           |
| Population Density, people/square km                | 11.3                  | 297.2    | 2,408.1 |                           |
| Distance, km  | 2,408.8               | 539.5    | 73      | 3,022.3                   |
| Percent in Each Classification                      | 79.7                  | 17.9     | 2.4     |                           |
| OAKRIDGE, TN (RADIOACTIVE MATERIALS)                |                       |          |         |                           |
| Population Density, people/square km                | 7.9                   | 317.3    | 2,132   |                           |
| Distance, km  | 1,915.3               | 272.4    | 31.3    | 2,219.2                   |
| Percent in Each Classification                      | 86.3                  | 12.3     | 1.4     |                           |
| BUFFALO, NY (RADIOACTIVE MATERIALS)                 |                       |          |         |                           |
| Population Density, people/square km                | 10.5                  | 291.1    | 2,343.1 |                           |
| Distance, km  | 2,245.2               | 545      | 60.6    | 2,851.7                   |
| Percent in Each Classification                      | 78.7                  | 19.1     | 2.1     |                           |
| ST. LOUIS, MO (RADIOACTIVE MATERIALS)               |                       |          |         |                           |
| Population Density, people/square km                | 7.3                   | 321      | 2,467.9 |                           |
| Distance, km  | 1,430.1               | 197.3    | 35.9    | 1,664                     |
| Percent in Each Classification                      | 85.9                  | 11.9     | 2.2     |                           |
| LARGO, FL (RADIOACTIVE MATERIALS)                   |                       |          |         |                           |
| Population Density, people/square km                | 9                     | 353.5    | 2,036.7 |                           |
| Distance, km  | 2,277.4               | 465.3    | 49      | 2,792.1                   |
| Percent in Each Classification                      | 81.6                  | 16.7     | 1.8     |                           |
| CHARLESTON, SC (RADIOACTIVE MATERIALS)              |                       |          |         |                           |
| Population Density, people/square km                | 9.7                   | 337.2    | 2,139.9 |                           |
| Distance, km  | 2,244.7               | 467.5    | 37.1    | 2,750.3                   |
| Percent in Each Classification                      | 81.6                  | 17       | 1.4     |                           |
| SAVANNAH RIVER SITE, SC (RADIOACTIVE MATERIALS)     |                       |          |         |                           |
| Population Density, people/square km                | 9.3                   | 345.4    | 2,109   |                           |
| Distance, km  | 2,051.1               | 455.3    | 40.6    | 2,548                     |
| Percent in Each Classification                      | 80.5                  | 17.9     | 1.6     |                           |
| ALBUQUERQUE (CHEMICALS)                             |                       |          |         |                           |
| Population Density, people/square km                | NA                    | NA       | NA      |                           |
| Distance, km  | 8                     | 24       | 8       | 40                        |
| Percent in Each Classification                      | 20                    | 60       | 20      |                           |

**Table G.6–1. SNL/NM Shipping Locations, Material Type, Route Characteristics, and Total Distance (continued)**

| SHIPMENT FROM SNL/NM TO LOCATION<br>(MATERIAL TYPE) | ROUTE CHARACTERISTICS |          |         | TOTAL<br>DISTANCE<br>(km) |
|---|-----------------------|----------|---------|---------------------------|
|   | RURAL                 | SUBURBAN | URBAN   |                           |
| SILVERDALE, WA (EXPLOSIVES)                         |                       |          |         |                           |
| Population Density, people/square km                | NA                    | NA       | NA      |                           |
| Distance, km  | 2,069.1               | 288.8    | 48.1    | 2,406                     |
| Percent in Each Classification                      | 86                    | 12       | 2       |                           |
| ALBUQUERQUE AREA (RECYCLABLE WASTES)                |                       |          |         |                           |
| Population Density, people/square km                | NA                    | NA       | NA      |                           |
| Distance, km  | 10                    | 30       | 10      | 50                        |
| Percent in Each Classification                      | 20                    | 60       | 20      |                           |
| ALBUQUERQUE CITY (RECYCLABLE WASTES)                |                       |          |         |                           |
| Population Density, people/square km                | NA                    | NA       | NA      |                           |
| Distance, km  | 6.4                   | 19.2     | 6.4     | 32                        |
| Percent in Each Classification                      | 20                    | 60       | 20      |                           |
| RICHLAND, WA (LLW)                                  |                       |          |         |                           |
| Population Density, people/square km                | 3.7                   | 377.4    | 2,140.3 |                           |
| Distance, km  | 2,324                 | 224      | 36      | 2,584                     |
| Percent in Each Classification                      | 89.9                  | 8.7      | 1.4     |                           |
| NEVADA TEST SITE, NV (LLW)                          |                       |          |         |                           |
| Population Density, people/square km                | 3.3                   | 486.4    | 2,357.5 |                           |
| Distance, km  | 945                   | 68       | 25      | 1,038                     |
| Percent in Each Classification                      | 91                    | 7        | 2       |                           |
| SAVANNAH RIVER SITE, SC (LLMW)                      |                       |          |         |                           |
| Population Density, people/square km                | 9.3                   | 345.4    | 2,109   |                           |
| Distance, km  | 2,051.1               | 455.3    | 40.6    | 2,548                     |
| Percent in Each Classification                      | 80.5                  | 17.9     | 1.6     |                           |
| CLIVE, UT (LLW, HAZARDOUS)                          |                       |          |         |                           |
| Population Density, people/square km                | NR                    | NR       | NR      |                           |
| Distance, km  | 1,533                 | 156      | 33      | 1,722                     |
| Percent in Each Classification                      | 89                    | 9        | 2       |                           |
| LOS ALAMOS, NM (TRU/MTRU)                           |                       |          |         |                           |
| Population Density, people/square km                | NR                    | NR       | NR      |                           |
| Distance, km  | 132.1                 | 27       | 8.3     | 167.4                     |

**Table G.6–1. SNL/NM Shipping Locations, Material Type, Route Characteristics, and Total Distance (concluded)**

| SHIPMENT FROM SNL/NM TO LOCATION<br>(MATERIAL TYPE) | ROUTE CHARACTERISTICS |          |       | TOTAL<br>DISTANCE<br>(km) |
|---|-----------------------|----------|-------|---------------------------|
|   | RURAL                 | SUBURBAN | URBAN |                           |
| <i>Percent in Each Classification</i>               | 78.9                  | 16.1     | 5     |                           |
| <b>ARAGONITE, UT (BIOHAZARDOUS WASTE)</b>           |                       |          |       |                           |
| <i>Population Density, people/square km</i>         | NA                    | NA       | NA    |                           |
| <i>Distance, km</i>                                 | 984.8                 | 105.8    | 24.4  | 1,114                     |
| <i>Percent in Each Classification</i>               | 88.4                  | 9.5      | 2.2   |                           |

Sources: DOE 1996h, SNL 1992a

km: kilometer

LLMW: low-level mixed waste

LLW: low-level waste

MTRU: mixed transuranic

NA: Not applicable

NR: not reported

TRU: transuranic

Note: Only radioactive material and waste require population density information for the RADTRAN 4 model.

**Table G.6–2. Comparison of Incident-Free Impacts with Variations in Transport Index Values<sup>a</sup>**

| TRANSPORT INDEX | CREW DOSE<br>(person-rem) | DOSE TO PUBLIC<br>(person-rem) |                      |                       |
|-----------------|---------------------------|--------------------------------|----------------------|-----------------------|
|                 |                           | OFF-LINK                       | ON-LINK              | STOP                  |
| <b>13</b>       | $1.12 \times 10^{-1}$     | $1.7 \times 10^{-2}$           | $7.1 \times 10^{-2}$ | $6.02 \times 10^{-1}$ |
| <b>8</b>        | $5.6 \times 10^{-2}$      | $1.1 \times 10^{-2}$           | $4.4 \times 10^{-2}$ | $3.71 \times 10^{-1}$ |
| <b>5</b>        | $3.5 \times 10^{-2}$      | $6.7 \times 10^{-3}$           | $2.7 \times 10^{-2}$ | $2.32 \times 10^{-1}$ |

Sources: Original, SNL 1992a

hr: hour

km: kilometer

m: meter

rem: Roentgen equivalent, man

<sup>a</sup> Shipment to Mountaintop, PA; 5.2-m package; stop time of 0.011 hr/km

## G.7 ONSITE TRANSPORTATION IMPACTS

Onsite transportation impacts due to the movement of various materials and waste within SNL/NM and the KAFB site boundary would be small compared to the offsite transportation impacts. This is due to the shorter travel distance, smaller quantities, and lower population density. This assumption was supported by quantifying the impacts for the Expanded Operations Alternative onsite shipments/transfers. Table G.7–1 presents the

projected number of onsite transfers of various materials and wastes, along with expected travel distances. These distances were assumed to be suburban type.

Transportation impacts would include incident-free radiological doses and nonradiological traffic fatalities. The impacts calculated for each of these are presented in Table G.7–2 for the Expanded Operations Alternative. The onsite impacts would be much smaller than the offsite transportation impacts summarized in Table G.5–1. Therefore, onsite impacts were not evaluated in detail for all alternatives.

**Table G.7–1. Summary of Annual Onsite Transfers**

| MATERIAL TYPE                | MAXIMUM ROUND TRIP DISTANCE (km) | BASE YEAR <sup>a</sup> | NO ACTION ALTERNATIVE |                    | EXPANDED OPERATIONS ALTERNATIVE | REDUCED OPERATIONS ALTERNATIVE |
|------------------------------|----------------------------------|------------------------|-----------------------|--------------------|---------------------------------|--------------------------------|
|                              |                                  |                        | 2003                  | 2008               |                                 |                                |
| <b>Radioactive</b>           | 19                               | 10                     | 1,158 <sup>b</sup>    | 1,160 <sup>b</sup> | 1,198 <sup>b</sup>              | 1,145 <sup>b</sup>             |
| <b>Explosives</b>            | 32                               | 1,453                  | 2,675                 | 2,844              | 8,490                           | 665                            |
| <b>LLW</b>                   | 16                               | 761                    | 772                   | 772                | 775                             | 770                            |
| <b>LLMW</b>                  | 16                               | 35                     | 24                    | 24                 | 20                              | 28                             |
| <b>TRU/MTRU</b>              | 16                               | 4                      | 4                     | 4                  | 5                               | 2                              |
| <b>Hazardous (RCRA)</b>      | 16                               | 800                    | 800                   | 800                | 800                             | 800                            |
| <b>Municipal Solid Waste</b> | 80                               | 896 <sup>c</sup>       | 155                   | 155                | 155                             | 155                            |
| <b>ER RCRA</b>               | 16                               | NA                     | 1,407                 | NA                 | 1,407                           | 1,407                          |

Sources: SNL 1996a, SNL/NM 1998a, SNL/NM 1997b

ER: Environmental Restoration

KAFB: Kirtland Air Force Base

km: kilometer

LLMW: low-level mixed waste

LLW: low-level waste

MTRU: mixed transuranic

NA: Not applicable

NR: Not reported

RCRA: Resource Conservation and Recovery Act

TRU: transuranic

<sup>a</sup> The base year varies depending on information provided in the Facilities and Safety Information Document (FSID) (SNL/NM 1997b). Typically, the base year is 1996 or 1997, as appropriate.

<sup>b</sup> Increase in transfers due to medical isotope production

<sup>c</sup> Includes waste managed at the KAFB landfill

**Table G.7–2. Onsite Transportation Impacts**

| TYPE OF IMPACT                    | EXPANDED OPERATIONS ALTERNATIVE (NUMBER OF FATALITIES) |
|-----------------------------------|--|
| <b>Radiological Incident-Free</b> | 1.7×10 <sup>-4</sup>                                   |
| <b>Traffic Fatalities</b>         | 5.7×10 <sup>-3</sup>                                   |

Source: DOE 1996h, SNL 1986